

New species of *Catenularia* and *Fuscocatenula* from Xishuangbanna, China

JING-WEN LIU¹, YA-FEN HU¹, RU-QIANG CUI¹, RAFAEL F. CASTAÑEDA-RUIZ², ZHAO-HUAN XU¹, JIAN MA^{1*}

¹ College of Agronomy, Jiangxi Agricultural University, Nanchang, Jiangxi 330045, China

² Instituto de Investigaciones Fundamentales en Agricultura Tropical ‘Alejandro de Humboldt’ (INIFAT), Académico Titular de la “Academia de Ciencias de Cuba”,
Calle 1 Esq. 2, Santiago de Las Vegas, C. Habana, Cuba, C.P. 17200

* CORRESPONDENCE TO: majian821210@163.com; jxaumj@126.com

ABSTRACT—Three new anamorphic fungi, *Catenularia yunnanensis*, *Fuscocatenula nabanhensis* and *F. chinensis*, are described and illustrated from specimens collected on dead branches of unidentified plants in Xishuangbanna, Yunnan Province, China. *Catenularia yunnanensis* is characterized by its acrogenous, basocatenate, aseptate, rounded-obconic, smooth conidia with 2–3 blunt corners at the distal end when viewed from above. *Fuscocatenula nabanhensis* is distinguished by its basocatenate, aseptate, cylindrical to slightly cuneiform, smooth conidia with protracted maturation and round outline. *Fuscocatenula chinensis* is denoted by its basocatenate, aseptate, obovoid, smooth conidia with round outline. The three species are described, illustrated, and compared with similar taxa. A key to species of *Fuscocatenula* is provided.

KEY WORDS—asexual fungi, *Chaetosphaeriaceae*, hyphomycetes, conidial fungi, taxonomy

Introduction

Catenularia Grove was erected with *Catenularia simplex* Grove [= *C. cupulifera* (Berk. & Broome) Réblová & A.N. Mill.] as the type species (Hughes 1965, Ellis 1971, Réblová & al. 2021), and was mainly characterized by macronematous, mononematous conidiophores, and integrated, terminal, monophialidic, percurrently extending conidiogenous cells with a funnel shaped collarete at

the apex, and basocatenate, aseptate, cuneiform or rounded-obconic conidia with several blunt corners at the distal end when viewed from above (Hughes 1965, Ellis 1971, Réblová & al. 2021). Hughes (1965) reviewed the history of *Catenularia*, and excluded ten species from the genus. Subsequently, Réblová & al. (2021) evaluated the generic concept of *Catenularia* and its relationships with morphologically similar fungi based on molecular and morphological data, accepted eleven species, and proposed the segregate genus *Fuscocatenula* Réblová & A.N. Mill. for *Chaetosphaeria submersa* Z.L. Luo & al. (type) and *Catenularia variegata* H.H. Li & X.G. Zhang, readily distinguishable from typical *Chaetosphaeria* and *Catenularia* by pigmented conidia with protracted maturation and round outline.

Xishuangbanna Dai Autonomous Prefecture, located in the southwestern part of Yunnan Province, China, is a famous biodiversity hotspot (Cao & Zhang 1997). It lies in 21.17–22.67°N 99.92–101.83°E and has a mountainous topography with remarkable seasonal climate variations. Its mean annual minimum and maximum temperatures are 19.3–23.9°C, and the total annual precipitation is about 1493 mm. Such favorable conditions maintain large areas of tropical rain forest which contain rich biodiversity. During our mycological surveys in the forest ecosystems of this region, three hyphomycetes with morphological features typical of *Catenularia* (Grove 1886) and *Fuscocatenula* (Réblová & al. 2021) were collected on dead branches. However, these collections are morphologically easily distinguishable from the currently accepted species of these genera and are proposed here as new taxa.

Materials & methods

Samples of dead branches were collected from humid environments and river bank in the forest ecosystems of Xishuangbanna, and placed in ZiplocTM bags for transporting to the laboratory, where they were processed, and examined as described by Ma & al. (2011). Fungi were mounted in a drop of lactic acid on microscope slides, examined and photographed with an Olympus microscope (model BX 53) under a 100× (oil immersion) objective at the same background and scale. Adobe Photoshop 7.0 was used for image processing to assemble photographs into images. Single-spore isolations were made on potato dextrose agar (PDA) following Goh (1999) but were unsuccessful after several attempts. The specimens are deposited in the Herbarium of Jiangxi Agricultural University, Plant Pathology, Nanchang, Jiangxi, China (HJAUP).

Taxonomy

Catenularia yunnanensis Jing W. Liu, Jian Ma & R.F. Castañeda, **sp. nov.** FIG. 1

IF 559608

Differs from *Catenularia catenulata* by its smaller conidia with 2–3 corners; from *C. cupulifera*, *C. minor*, and *C. novae-zelandiae* by its smaller conidia with 2–3 corners and by the absence of capitate hyphae; and from *C. cubensis* by its wider conidia with 2–3 corners and by the absence of capitate hyphae.

TYPE: China, Yunnan Province: Xishuangbanna Dai Autonomous Prefecture, the Xishuangbanna Tropical Botanical Garden, on dead branches of an unidentified broadleaf tree, 9 July 2021, J.W. Liu (**Holotype**, HJAUP M0086-2).

ETYMOLOGY: refers to Yunnan province where the type was collected.



FIG. 1. *Catenularia yunnanensis* (holotype, HJAUP M0086-2). Conidiophores, conidiogenous cells, and conidia.

COLONIES on natural substratum effuse, brown, hairy. Mycelium superficial and immersed, composed of branched, septate, pale brown to brown, smooth-walled hyphae. Capitate hyphae absent. CONIDIOPHORES macronematous, mononematous, simple, erect, straight or flexuous, cylindrical, smooth, 1–5-septate, brown, paler towards to the apex, thick-walled, $135\text{--}175 \times 4.5\text{--}5.5 \mu\text{m}$. CONIDIOGENOUS CELLS monophialidic, integrated, terminal, cylindrical, brown to pale brown, percurrently extending, with a distinct, funnel-shaped collarete at the apex, $25\text{--}40 \mu\text{m}$ long, $4\text{--}6 \mu\text{m}$ diam. CONIDIA basocatenate, up to 11 or more, aseptate, rounded-obconic, smooth, truncate at the base, with 2–3 blunt corners at the distal end when viewed from above, $7.5\text{--}8 \mu\text{m}$ long, $7\text{--}8 \mu\text{m}$ diam. at the apical end, $1.5\text{--}2.5 \mu\text{m}$ diam. at the truncate base.

COMMENTS—Among the known species of *Catenularia*, *C. yunnanensis* is most similar to *C. cubensis* Hol.-Jech., *C. cupulifera*, *C. novae-zelandiae* (S. Hughes & Shoemaker) Réblová & A.N. Mill., *C. catenulata* (Z.L. Luo & al.) Réblová & A.N. Mill., and *C. minor* (Hol.-Jech.) Réblová & A.N. Mill. in conidial shape (Holubová-Jechová 1982, Réblová & al. 2021). However, *C. catenulata* differs by its turbinate-triangular, larger conidia ($13\text{--}15 \times 12\text{--}14 \mu\text{m}$) with 3–4 corners (Luo & al. 2019, Réblová & al. 2021); *C. cupulifera* by its cuneiform, larger conidia ($10.5\text{--}13.5 \times 7\text{--}9.5 \mu\text{m}$) with (3–)4(–5) corners (Réblová & al. 2021); *C. cubensis* by its rounded-obconic to broadly obovoid, narrower conidia ($3.5\text{--}5.5 \mu\text{m}$ wide) with 3 corners (Holubová-Jechová 1982, Réblová & al. 2021); *C. minor* by its cuneiform to rounded-obconic to obtriangular, larger conidia ($7.5\text{--}10.5 \times 6.5\text{--}11.5 \mu\text{m}$) with 3–5 corners (Holubová-Jechová 1983, Réblová & al. 2021); and *C. novae-zelandiae* by its larger conidia ($11.5\text{--}17.5 \times 14.5\text{--}18.5 \mu\text{m}$) with 4–5 corners (Hughes 1965, Réblová & al. 2021). In addition, *C. cubensis*, *C. cupulifera*, *C. novae-zelandiae*, and *C. minor* have capitate hyphae, which are not found in *C. catenulata* and *C. yunnanensis*.

Fuscocatenula nabanhensis Jing W. Liu, Jian Ma & R.F. Castañeda, **sp. nov.** FIG. 2
IF 559609

Differs from *Fuscocatenula submersa* and *F. variegata* by its cylindrical to slightly cuneiform, smaller conidia.

TYPE: China, Yunnan Province: Xishuangbanna Dai Autonomous Prefecture, the Nabanhe National Nature Reserve, on dead branches of an unidentified broadleaf tree, 9 July 2021, J.W. Liu (**Holotype**, HJAUP M2061).

ETYMOLOGY: Latin, *nabanhensis* referring to the place, Nabanhe, where the fungus was collected.



FIG. 2. *Fuscocatenula nabanhensis* (holotype, HJAUP M2061). A–C. Conidiophores, conidiogenous cells, and conidia; D. Conidia.

COLONIES on natural substratum effuse, brown, hairy. Mycelium superficial and immersed, composed of branched, septate, pale brown to brown, smooth-walled hyphae. Capitate hyphae absent. CONIDIOPHORES macronematous, mononematous, simple, erect, straight or flexuous, cylindrical, smooth, 2–6-septate, brown, paler towards to the apex, thick-walled, $55\text{--}130 \times 3.5\text{--}4\text{ }\mu\text{m}$. CONIDIOGENOUS CELLS monophialidic, integrated, terminal, cylindrical,

pale brown, percurrently extending, with a distinct, funnel-shaped collarete at the apex, 20–30 μm long, 3.5–5 μm diam. CONIDIA basocatenate, up to 18 or more, aseptate, cylindrical to slightly cuneiform, smooth, 5–6 $\times$ 3–3.5 μm , rounded at apex, truncate at base, hyaline while young, becoming pale brown at mature.

COMMENTS—Réblová & al. (2021) proposed *Fuscocatenula*, and to date only *F. submersa* (Z.L. Luo & al.) Réblová & A.N. Mill. and *F. variegata* (H.H. Li & X.G. Zhang) Réblová & A.N. Mill. have been included. *Fuscocatenula submersa* differs from *F. nabanensis* by its cuneiform, larger conidia (21–27 $\times$ 12–14 μm), and longer and wider conidiophores (380–596 $\times$ 15–21 μm) (Luo & al. 2019, Réblová & al. 2021); and *F. variegata* by its obovoid, larger conidia (8.5–11 $\times$ 5.5–7.5 μm) and longer and wider conidiophores (150–270 $\times$ 4.5–8 μm) (Li & al. 2017, Réblová & al. 2021).

Fuscocatenula chinensis Jing W. Liu, Jian Ma & R.F. Castañeda, **sp. nov.** FIG. 3
IF 559610

Differs from *Fuscocatenula submersa* by its obovoid, smaller conidia and shorter and narrower conidiophores; and from *F. variegata* by its longer and narrower conidia and longer conidiophores.

TYPE: China, Yunnan Province: Xishuangbanna Dai Autonomous Prefecture, the Nabanhe National Nature Reserve, on decaying twigs of an unidentified broadleaf tree, 9 July 2021, J.W. Liu (**Holotype**, HJAUP M0041).

ETYMOLOGY: refers to China, in which the fungus was collected.

COLONIES on natural substratum effuse, brown, hairy. Mycelium superficial and immersed, composed of branched, septate, pale brown to brown, smooth-walled hyphae. Capitate hyphae absent. CONIDIOPHORES macronematous, mononematous, simple, erect, straight or flexuous, smooth, 6–11-septate, brown to dark brown, paler towards to the apex, thick-walled, 275–360 $\times$ 6.5–8 μm . CONIDIOGENOUS CELLS monophialidic, integrated, terminal, cylindrical, brown to pale brown, percurrently extending, with a distinct, funnel-shaped collarete at the apex, 44–75 μm long, 5–7 μm diam. CONIDIA basocatenate, aseptate, obovoid, smooth, 11–12 $\times$ 5–5.5 μm , rounded at apex, truncate at base, with a protracted maturation, the conidia are hyaline and only later become pale brown, while still attached in a chain, sometimes the chain formed by hyaline conidia with only several mature pigmented conidia.



FIG. 3. *Fuscocatenula chinensis* (holotype, HJAUP M0041). A–D. Conidiophores, conidiogenous cells, and conidia; E. Conidia. (the hyaline and pale-brown color assumed a greenish cast during processing).

COMMENTS—*Fuscocatenula chinensis* is morphologically similar to *F. submersa* and *F. variegata*, but *F. submersa* differs by its cuneiform, larger conidia ($21\text{--}27 \times 12\text{--}14\ \mu\text{m}$), and longer and wider conidiophores ($380\text{--}596 \times 15\text{--}21\ \mu\text{m}$) (Luo & al. 2019, Réblová & al. 2021); and *F. variegata* by its shorter and wider conidia ($8.5\text{--}11 \times 5.5\text{--}7.5\ \mu\text{m}$) and shorter conidiophores ($150\text{--}270\ \mu\text{m}$ long) (Li & al. 2017, Réblová & al. 2021). In addition, *F. chinensis* differs from *F. nabanhensis*, which has cylindrical to slightly cuneiform, smaller conidia and shorter and narrower conidiophores.

Key to *Fuscocatenula* species

1. Conidia cylindrical to slightly cuneiform, $5\text{--}6 \times 3\text{--}3.5\ \mu\text{m}$ *F. nabanhensis*
1. Conidia obovoid or cuneiform, $\geq 8.5 \times 5\ \mu\text{m}$ 2
2. Conidia cuneiform, $21\text{--}27 \times 12\text{--}14\ \mu\text{m}$ *F. submersa*
2. Conidia obovoid, $\leq 12 \times 7.5\ \mu\text{m}$ 3
3. Conidia $8.5\text{--}11 \times 5.5\text{--}7.5\ \mu\text{m}$; conidiophores 10–12-septate, $150\text{--}270 \times 4.5\text{--}8\ \mu\text{m}$ *F. variegata*
3. Conidia $11\text{--}12 \times 5\text{--}5.5\ \mu\text{m}$; conidiophores 6–11-septate, $275\text{--}360 \times 6.5\text{--}8\ \mu\text{m}$ *F. chinensis*

Acknowledgments

The authors express gratitude to Dr. P.M. Kirk (The Royal Botanic Gardens, UK) and Dr. De-Wei Li (The Connecticut Agricultural Experiment Station, USA) for serving as pre-submission reviewers and to Dr. Shaun Pennycook for nomenclatural review and Dr. Lorelei L. Norvell for editorial review. This project was supported by the National Natural Science Foundation of China (Nos. 31970018, 32160006, 31360011).

Literature cited

- Cao M, Zhang JH. 1997. Tree species diversity of tropical forest vegetation in Xishuangbanna, SW China. *Biodiversity & Conservation* 6: 995–1006. <https://doi.org/10.1023/A:1018367630923>
- Ellis MB. 1971. *Dematiaceous hyphomycetes*. Commonwealth Mycological Institute, Kew, Surrey, England. 513 p.
- Holubová-Jechová V. 1982. New or interesting phialidic hyphomycetes from Cuba. *Mycotaxon* 15: 277–292.
- Holubová-Jechová V. 1983. Studies on hyphomycetes from Cuba I. *Česká Mykologie* 37: 12–18.
- Hughes SJ. 1965. New Zealand fungi 3. *Catenularia* Grove. *New Zealand Journal of Botany* 3: 136–150. <https://doi.org/10.1080/0028825X.1965.10876990>
- Goh T.K. 1999. Single-spore isolation using a hand-made glass needle. *Fungal Diversity* 2: 47–63.
- Grove WB. 1886. New or noteworthy fungi: part III. *Journal of Botany* 24: 197–206.
- Li HH, Zhang K, Xia JW, Wang JY, Yang CL, Zhang XG. 2017. *Catenularia variegata* sp. nov. from southern China, and a first Chinese record of *Xylocladium clautriavii*. *Mycotaxon* 132: 621–634. <https://doi.org/10.5248/132.621>

- Luo ZL, Hyde KD, Liu JK, Maharachchikumbura SSN, Rajesh J, Bao DF, Bhat DJ & al. 2019. Freshwater *Sordariomycetes*. *Fungal Diversity* 99: 451–660. <https://doi.org/10.1007/s13225-019-00438-1>
- Ma J, Wang Y, Ma LG, Zhang YD, Castaneda-Ruiz RF, Zhang XG. 2011. Three new species of *Neosporidesmium* from Hainan, China. *Mycological Progress* 10: 157–162. <https://doi.org/10.1007/s11557-010-0685-2>
- Réblová M, Nekvindová J, Miller AN. 2021. Phylogeny and taxonomy of *Catenularia* and similar fungi with catenate conidia. *MycKeys* 81: 1–44. <https://doi.org/10.3897/mycokeys.81.67785>